Observations in Macro and Micro algae Contributions to Bacteria Populations and Implications for Beach Advisories

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November 2006

Background: Since 2004 Santa Cruz County EHS has noticed that both Capitola Beach and Cowell Beach have been posted with Water Quality Advisories the first or second week in June with no obvious cause. In the past we have noticed large flocks of birds and have always blamed the beach postings on large amounts of bird droppings found when the birds are present. Many times there was no obvious bird presence nor has there been any sewage discharges to account for the increase in bacteria levels.

The County of Santa Cruz Environmental Health Services conducted tests on kelp found in the tidal zone at several Santa Cruz County beaches to determine if decaying kelp could be one of the sources of elevated fecal indicator bacteria that has caused Capitola and Cowell Beaches to be posted with swimming advisories.

In 2005 kelp samples were taken on June 27, July 6, July 7, July 11, July 19, and August 1. In 2006 kelp samples were taken a single time on June 26. In addition, samples were taken and analyzed from sand at various depths to ground water and also from a tidal impoundment at Santa Cruz Main Beach.

Sample results from the tidal impoundment indicated that there was an additional source of bacteria as the pond had sat in the sun for a period of time and there was no evidence of bird contribution since there were no droppings in the water or bird feathers along the edges.

This led EHS to seek another source of elevated bacteria and led us to analyze micro algae since there had been increased observations of red tide in the area.

Materials and Methods

Kelp samples were collected and put into sterile Nasco Whirl-Pak sample bags from Capitola Beach, Hooper's Beach, the beach at 38th Avenue, Cowell Beach, Mitchell's Cove Beach, Natural Bridges Beach, and Waddell Beach.

Sand samples were extracted from a hole dug to the water level and collected from 3", 6", and 12". Samples were taken from Schwan Lake, San Lorenzo River mouth, Neary Lagoon, Soquel Creek mouth, and Aptos Creek mouth. These sites were chosen due to proximity to ocean sample sites that are periodically posted with water quality advisories. These samples were also collected into Nasco Whirl-Pak sample bags using sterile tongue depressors.

Micro algae samples were taken using a plankton net that was dropped from Santa Cruz Municipal Pier, Capitola Pier, and Seacliff Cement Ship Pier. Samples were placed into Nasco Whirl Pak bags and sub-samples were sent to The California State Department of Health State Mussel Watch Program for identification to species.

After returning to the Public Health Lab a small amount of sterile water was added to each bag containing a small amount of kelp or sand. The sample was then mashed to break it up and the bag was filled to the 100ml. mark. Water from each bag was then analyzed using Idexx Colilert-18, Idexx Enterolert, or membrane-filtration for fecal coliform bacteria. Water from plankton tows and the sample tidal pond sample were analyzed after shaking the sample bag.

The bags were sealed and left to sit at room temperature in the Public Health Lab for twenty-four hours and re-tested using the same type of analysis done initially, Idexx Colilert-18, Idexx Enterolert, or membrane-filtration for fecal coliform bacteria. In some cases water was again tested after sitting at room temperature for a total of 48 hours.

Test results in all cases showed low levels of fecal indicator bacteria at initial testing and extremely high levels of bacteria as determined by Idexx Colilert-18 and membrane-filtration for fecal coliform bacteria. Idexx Enterolert analysis showed variable results. Waddell Beach results showed no bacteria initially or after 24 hours. Hooper's Beach, 38th Avenue Beach, and Waddell Beach were tested one time each for the 2005 samplings. Cowell Beach and Capitola Beach were the only sites sampled for kelp in 2006.

The sample from the tidal pond was not analyzed after the initial analysis.

Results are presented in the table below. Where there is a third set of numbers in the column it indicates that the sample was held for analysis for 48 hours after the initial analysis.

Several samples were tested to species from colonies tested for fecal coliform bacteria and extracted from positive E. coli results in Idexx Colilert-18 testing. Organisms found were:

E. coli
Serratia rubidaea
Klebsiella oxytaca
Klebsiella pneumoniae
Vibrio alginolyticus

Sample results are shown below. All sample results are expressed as MPN/100 mls. sample.

2005

Date/Location/ (Sample type)	**E.coli (0/24hrs)**	**Total Coli(0/24hrs)**	**Entero (0/24hrs)**	**Fecal Coli (0/24hrs)**
27June/Capitola Beach	no sample	no sample	no sample	pos/TNTC
/ Cowell Beach	no sample	no sample	no sample	pos/TNTC
/ Hooper's Beach	no sample	no sample	no sample	pos/TNTC
/Mitchell's Cove	no sample	no sample	no sample	pos/TNTC
6July/Capitola Beach	5 / >24192	5 / >24192	5 / >24192	no sample
/ 38th Ave.	5 / >24192	10 / >24192	5 / >24192	no sample
/ Cowell Beach	5 / >24192	10 / >24192	5 / 5	no sample
/Mitchell's Cove	5 / >24192	5 / >24192	5 / 933	no sample
/ Natural Bridges	5 / >24192	30 / >24192	5 / 5	no sample
/ Waddell Beach	5 / 5	5 / 5	5 / 5	no sample
11July/ Capitola	31 / >24192	98 / >24192	5 / 3076	no sample
19July/ Capitola	5 / >24192	5 / >24192	5 / 5	no sample
/ Cowell Beach	10 / >24192	31 / >24192	5 / 379	no sample
/ Mitchell's Cove	5 / >24192	31 / >24192	5 / 5	no sample
/ Natural Bridges	5 / >24192	5 / >24192	5 / 467	no sample
1Aug/Capitola/**H2O**	52/86	181/161	10/5	no sample
/Capitola/**kelp**	10/>24192	20/>24192	5/425	no sample
/Hooper's/**H2O**	171/132	594/256	5/5	no sample
/Hooper's/**kelp**	5/1956	5/2046	5/5	no sample
/38th/**H2O**	5/5	5/5	5/5	no sample
/38th/**kelp**	5/5/146	10/>24192/>24192	5/4352	no sample
/Cowell/**H2O**	52/63	201/85	10/5	no sample
/Cowell/**kelp**	20/24192	20/>24192	5/>24192	no sample
/Mitchell's/**H2O**	5/5	10/5	5/5	no sample
/Mitchell's/**kelp**	5/>24192	5/>24192	5/5	no sample
/Nat. Bridges/**H2O**	5/5	5/5	5/5	no sample
/ Nat. Bridges/**kelp**	5/5/5	5/>24192/>24192	5/5	no sample
/Waddell/**H2O**	5/5	5/5	5/5	no sample
/ Waddell/**kelp**	5/5/5	5 / >24192/>24192	5 / 5	no sample

2006

Date/Location/ (Sample type)	**E.coli (0/24hrs)**	**Total Coli(0/24hrs)**	**Entero (0/24hrs**	**Fecal Coli (0/24hrs)**
6 June/Cowell/**kelp**	228/2187	336/>24192	10/<5	no sample
/Cowell	61/>24192	130/>24192	31/>24192	no sample
/Cowell	<5/>24192	109/>24192	20/4611	no sample
/Capitola	<5/>24192	<5/>24192	<5/108	no sample
/Capitola	10/>24192	132/>24192	<5/52	no sample
/Capitola	74/>24192	529/>24192	10/24192	no sample
3 Oct./SC Wharf/**micro**	<5/20/<5	85/2603/1956	<5/<5/<5	no sample
/Capitola Pier	62/399/602	241/2909/3654	<5/>24192/>24192	no sample
/Seacliff Pier	<5/41/10	10/1355/1355	<5/>24192/>24192	no sample
24 Oct/SC Wharf	52/24192/19863	63/24192/24192	<5/10/>24192	no sample
/Capitola Pier	20/3624/2489	85/5794/2723	<5/<5/>24192	no sample
/Seacliff Pier	146/63/10	243/74/20	<5/10/30	no sample
31 Oct/SC Wharf	10/20/<5	10/73/193	<5/<5/<5	no sample
/Capitola Pier	20/31/158	98/41/195	<5/<5/<5	no sample
/Seacliff Pier	<5/<5/<5	<5/<5/<5	<5/<5/<5	no sample
29 June/ Tidal Pool	3255	14136	613	no sample
5 June/Schwan-3”/**sand**	20/<10/20	82/126/2481	242/452/73	no sample
/Schwan-6”	40/<10/10	60/20/1650	40/194/108	no sample
/Schwan-12”	20/40/884	40/126/>24192	126/60/121	no sample
/SLR Mouth-3”	20/40/63	148/104/201	<10/20/20	no sample
/SLR Mouth-6”	20/<10/350	20/40/1162	<10/<10/<5	no sample
/SLR Mouth-12”	<10/<10/379	<10/20/6488	<10/<10/<5	no sample
/Neary- 3”	<10/<10/379	<10/20/6488	<10/<10/<5	no sample
/Neary-6”	<10/62/6867	<10/62/10462	<10/20/20	no sample
/Neary-12”	<10/<10/2247	<10/<10/17329	<10/<10/<5	no sample
6 June/Aptos Cr-3”	194/703	218/839	<10/<5	no sample
/Aptos Cr-6”	62/97	126/228	<10/<5	no sample
/Aptos Cr-12”	20/52	104/120	<10/<5	no sample
/Soquel Cr-3”	40/10	82/187	20/31	no sample
/Soquel Cr-6”	60/52	126/187	<10/20	no sample
/Soquel Cr- 12”	104/74	242/313	82/20	no sample

2007

27 Nov/Red Tide	**E.coli (0/24/48hrs**)	**Total Coli(0/24/48hrs)**	**Entero (0/24/48hrs**	**Fecal Coli (0/24hrs)**
/ Capitola Pier	109/52/41	243/74/41	<5/<5/<5	no sample
/ SC Wharf	30/<5/<5	880/25000/25000	<5/<5/<5	no sample
/ Seacliff Pier	85/2143/3255	738/25000/25000	<5/<5/<5	no sample

Results: Both macro and micro algae results indicate that there is an increase in bacteria over time and can be influenced by both increased temperature and lack of circulation at public beaches. In the case of macro algae samples it was noticed that prior to large amounts of kelp on local beaches there was a significant swell that ripped up kelp that was then left to rot on the beach. In 2006 a small segment of Cowell beach was posted with Water Quality Advisories for 51 days due to a large block of kelp that was left to rot under the sand. Current beach management requirements do not allow the removal of kelp that is below the high tide line.

Red tide was suggested as a possible source of elevated bacteria due to a tidal pool developing with a high tide in an area known to have a bloom of red tide. Bacteria results for micro algae suggest that may also contribute to the elevation of bacteria in water samples as the bloom crashes and decomposes. Again, poor water circulation in an area can contribute to the increases of bacteria and the posting of Water Quality Advisories. Micro algae blooms have the added problem of characteristic odors that are offensive to some people. Various red tide organisms have odors that are species specific and some may be pleasant while others are extremely offensive.

Bacteria in sand samples grew much more slowly than did the macro and micro algae samples. Results indicate that bacteria do inhabit sand but the sand may have an inhibitory affect on the bacteria as well as a filtering affect for organic components.

Discussion: Results from the past two years of studies indicate that much of the bacteria that cause beach postings can come from natural sources. Since the State of California has the potential to experience heavy red tides in some areas this may explain elevated bacteria that has caused the posting of Water Quality Advisories independent of any other sources. Rotting kelp, while providing some nurturing for organisms at the lower level of the food chain, can be a source for elevated bacteria causing the posting of beaches with Water Quality Advisories and the economic loss to businesses in the beach areas.

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